

### **REMARKS**

Claims 2-15 and 17-20 are pending in this application. Claims 3, 14 and 19 are independent claims. Reconsideration and allowance of this application is respectfully requested.

### **Objection to the Drawings**

The Examiner has objected to the drawings under 35 C.F.R. § 1.83(a) as the drawings must show every feature of this invention specified in the claims. Specifically, the Examiner states that the feature of “the heat slug comprises a solder bonding layer formed on the surface of a heat slug that contacts the solder film” (claim 8) must be shown for the features cancelled from the claims.

In order to address this objection, Applicant replaces paragraph [0019] with the following paragraph that now adds a reference pointing to item 42 of FIG. 1, to clarify that 42 is the adhesive layer located between the heat slug 40 and the solder film 30. No new matter has been entered.

**[0019]** Between the chip 10 and the substrate 20, an under-filling portion 50 is formed to prevent cracking of the conductive bumps 16 due to the thermal expansion mismatch between the chip 10 and the substrate 20. Then, in order to promote the heat dissipation from the chip 10, a plate-shaped heat slug 40 is attached on the backside of the chip 10, on which an adhesion layer 14 is formed, using a solder film 30. The heat slug 40 is formed of a metal such as Cu, Al or CuW. In addition, grooves 43 are formed on the heat slug 40 to facilitate the heat dissipation by increasing the surface area of the heat slug 40. In addition, an adhesion solder bonding layer (~~not shown~~ 42), which is typically a Ni/Al, Ag, or Pd layer, can be formed on one side 41 of heat slug 40 contacting the solder film 30 to secure the bonding between the heat slug 40 and the conductive solder film 30, and an anodizing layer (not shown) is formed on the other side of the heat slug 40 to prevent oxidation of the heat slug 40. The solder film 30 is formed of a metal alloy which includes Pb, Sn, Ag, In and/or Bi. Such metal alloy typically has thermal conductivity of 25W/mK to 40W/mK and good adhesion strength. The solder film 30 preferably has a size equal to or greater than that of the semiconductor chip 10, so that the solder film 30 covers the whole backside of the chip 20. The layer 14, which promotes the adhesion between the semiconductor chip 10 and the solder film 30, typically has a multi-layer metal structure. Exemplary structures of the layer 14 include VN<sub>i</sub>/Au, Ti/VN<sub>i</sub>/Au, Cr/VN<sub>i</sub>/Au,

Ti/Pt/Au, Cr/CrCu/(Cu)/Au, TiW/(Cu, NiV)/Au, VN/Pd, Ti/VNi/Pd, Cr/VNi/Pd, Ti/Pt/Pd, Cr/CrCu/(Cu)/Pd, and TiW/(Cu, NiV)/Pd.

**Claim Rejections – 35 U.S.C. § 103**

Examiner rejects claims 3, 5, 6, 14 and 15 under 35 U.S.C. § 103(a) as being unpatentable over Ozawa (U.S. Patent No. 5,592,735) in view of Akasaki (U.S. Patent No. 5,217,922).

In addition to Applicant's previous arguments pertaining to impermissible hindsight and a lack of motivation to join Ozawa with Akasaki, Applicant additionally submits the following. Applicant's example embodiments as depicted in independent claims 3 and 14 consist of a heat slug 40 attached to a solder film 30 attached to a bonding multi-layer metal 14 attached to a semiconductor chip 10. Applicant's example embodiments operate to effectively remove heat from a semiconductor chip, such that it is important to make the bonding multi-layer as thin as possible, as heat conductivity of the adhesive may be lower than the heat slug (paragraph 0005). As discussed in paragraph [0019], the bonding multi-layer may be located between the soldering film and the semiconductor chip in order to act as an adhesive, without noticeably impairing heat conductivity, further emphasizing the importance of a thin adhesive layer.

Contrary to Applicant's invention, Ozawa comprises a heat slug attached to a solder film attached to a thermally conductive block attached to an adhesive composed of silver paste, which is attached to a semiconductor chip. The existence of both the thermally conductive block and the silver paste are discussed in Ozawa column 5, lines 4-8 and column 5, lines 58-64 and column 6, lines 44-51. The Examiner is asserting that it would have been obvious to remove both the "thermally conductive block" and silver paste of Ozawa, and substitute them with a metallized adhesive layer (depicted as 9A of FIG. 2F and described in column 7, lines 15-21 of Akasaki). Or, put another way, an artisan would know to substitute Ozawa's conductive block with an adhesive.

Applicant submits that the mere existence of Ozawa's conductive block is contrary to Applicant's embodiment, as the block impedes conduction. Applicant submits that the Examiner has not provided a motivation that would suggest the actual removal of Ozawa's conductive block. Therefore, Applicant requests the Examiner remove the art grounds of rejection for independent claims 3 and 14, such that these claims are allowable. For at least the same reasons, dependent claims 5, 6 and 15 are believed to be allowable.

Claims 2 and 13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Ozawa and Akasaki, and further in view of Haley. Haley discloses the material of the solder film and Haley discloses the plurality of “through holes” on the heat slugs. For at least the same reasons as discussed for independent claim 3 above, these dependent claims are believed to be allowable.

Claim 4 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Ozawa and Akasaki and further in view of Furukawa. Furukawa discloses the specific types of materials that could be used in Akasaki, which would not make the embodiment of claim 4 obvious, in and of itself. For at least the same reasons as discussed above relating to independent claim 3, this dependent claim is believed to be allowable.

Examiner rejects claim 7 under 35 U.S.C. § 103(a) as being unpatentable over Ozawa and Akasaki and further in view of Takahama. Takahama discloses the material of the heat slug, but would not make the embodiment of claim 7 obvious, in and of itself. For at least the same reasons as discussed above relating to independent claim 3, this dependent claim is believed to be allowable.

Claims 8 and 9 are rejected under U.S.C. § 103(a) as being unpatentable over Ozawa and Akasaki and further in view of Myers. For at least the same reasons as discussed above relating to independent claim 3, this dependent claim is believed to be allowable.

Claim 10 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Ozawa and Akasaki and further in view of Jeong. For at least the same reasons as discussed above relating to independent claim 3, this dependent claim is believed to be allowable.

Claims 11 and 12 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Ozawa and Akasaki and further in view of Hawthorne. For at least the same reasons as discussed above relating to independent claim 3, this dependent claim is believed to be allowable.

Claims 17 and 19 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Hawthorne in view of Ozawa and further in view of Akasaki. For at least the same reasons as

discussed above relating to independent claims 3 and 14, this dependent claim is believed to be allowable.

Claim 18 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Hawthorne, Ozawa and Akasaki, and further in view of Takahama. For at least the same reasons as discussed above relating to independent claims 3 and 14, this dependent claim is believed to be allowable.

Claim 20 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Hawthorne, Ozawa and Akasaki, and further in view of Jeong. For at least the same reasons as discussed above relating to independent claims 3, 14 and 19, this dependent claim is believed to be allowable.

### **CONCLUSION**

In view of the above, Applicants earnestly solicit reconsideration and allowance of all of the pending claims.

Should there be any matters that need to be resolved in the present application, the Examiner is respectfully requested to contact the telephone number of the undersigned below.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

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By: \_\_\_\_\_

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